

Radon Testing at Radford Army Ammunition Plant
by

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ABSTRACT

Radon testing of buildings in all geological areas of Radford Army Ammunition Plant showed only 11 buildings of the 511 tested had radon levels greater than 4.0 picocuries per liter of air (4.0 pCi/l). Alpha track monitors were used for 3-month screen tests of these buildings. Any buildings having a radon content greater than 4.0 pCi/l were tested for 12-months. Mitigation by air dilution reduced the radon content in 10 buildings to less than 4.0 pCi/l.

Ducts are being installed in the 11th building to also reduce the radon content by air dilution.

INTRODUCTION

Radon is a radioactive gas resulting from the natural decay of uranium and thorium. You cannot see it, smell it or taste it. The earth's crust contains various amounts of U-238 and Th-232 which decay, through a number of steps, to radon 222 and 220, respectively. Both Rn-222 and Rn-220 also decay to a number of radioactive daughters. The portions of interest in the decay schemes of Rn-222 and Rn-220 are shown in Figures 1 and 2, respectively.

The only known health effect associated with long-term exposure to elevated levels of radon is an increased risk of developing lung cancer.¹ However, not everyone exposed to elevated levels of radon will develop lung cancer. In general, the risk increases as the level of radon and the length of exposure increase.

In the outdoor air, radon is diluted to such low concentrations that it is usually nothing to worry about. However, once inside an enclosed space (such as a home) radon can accumulate. Indoor levels depend on the building's construction and the concentration of radon in the underlying soil. Radon can enter the home through very small spaces, such as cracks in concrete, dirt floors, sumps, joints and hollow block walls.

Radon can also enter water in private wells and be released in a home when the water is used. Usually, radon is not a problem with large community water supplies, where it would likely be released into the outside air before the water reaches a home.

In some unusual situations, materials used in the construction of the house will release radon. For example, a home with a large stone fireplace.

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Radon has always been present in the air. Concern over elevated indoor concentrations first arose in the late 1960s when homes were found in the West that had been built with materials contaminated by waste from uranium mines.¹ Since then, cases of high indoor radon levels have been found in many parts of the country. The dilemma is that no one knows which homes have a problem and which do not.

The U. S. Army is concerned about the health of its soldiers, military families and its civilian work force. The Army's radon program² is to (1) identify buildings containing radon levels exceeding United States Environmental Protection Agency (EPA) guidelines, (2) take appropriate steps to reduce radon levels in these buildings, (3) resurvey all buildings where mitigation has taken place and (4) ensure that newly constructed buildings are within EPA guidelines.

Radford Army Ammunition Plant is a diverse installation made up of eight major production areas. It is built beside the New River in Southwestern Virginia on old farm land. Geologically, the production areas are located on land deposited by the river as the Eastern United States was formed. The section of the plant known as Staff Village is on a limestone outcrop. Regional geologic maps refer to the general area in which the plant is located as the Pulaski Fault.

Buildings were tested for radon based on priorities established by the Army.² First (priority 1): hospital and living quarters. Second (priority 2): areas having 24-hours operations (operation centers, production areas, fire and security headquarters and test and evaluation facilities). Third (priority 3): all other buildings routinely inhabited.

DISCUSSION

Indoor radon levels were tested in 511 buildings during late winter and early spring in 1990 when doors and windows were generally closed. The detectors were placed in the lowest level of priority 1 buildings. Detectors in priority 2 and 3 buildings were placed in the lowest inhabited areas where minimum circulation occurred. The detectors stayed in place for 90 days. If radon was found to exceed 4.0 picocuries per liter of air (4 pCi/l) after a 90-day test period, a 1-year test period followed to substantiate the 90-day test results.

The Army chose an alpha track detector for monitoring radon. The detector (Figure 3) consists of a small strip of plastic placed in a 1 1/2-inch outside diameter plastic holder with a top containing nine 1/4-inch holes. Alpha particles released when radon decays, hit the plastic strip and make microscopic tracks. These tracks become visible when the plastic strip is immersed in an etching solution at the laboratory. The number of tracks on the strip enables the technicians to calculate the average radon concentration in the building during the testing period.

To assure that test results generated by the radon program are accurate, a quality assurance and quality control program² specified by the Army was followed. Detectors and data summary sheets containing only the installations name, detector's serial number and dates of placement and retrieval was the only information provided to the laboratory.

Detectors were supplied in sealed aluminum foil. The detectors were removed from the foil and placed in test locations. After the specified test period, an adhesive backed "Gold Seal" was placed over the holes in the top of the detector.

Other detectors were used to ensure accurate test results. Three percent of the detectors received were spiked samples (detectors exposed to known radon levels in an EPA radiation laboratory). Duplicate detectors were exposed at every tenth test location and located within six-inches of each other. Two detectors, referred to as field blanks, were also used from each box of detectors received. When shipping the detectors used in priority 1, 2 or 3 locations, the field blanks were removed from the aluminum foil packaging. The "Gold Seal" was immediately applied. The placement and retrieval dates were marked on the detectors using the same ink and handwriting. The field blanks were then mixed with the other detectors for shipment to the laboratory for analyses. A contractor was chosen by the Department of the Army to ensure that there was a 99.5 percent confidence in the initial measurements.

Radon testing of buildings in all geological areas of the Radford Army Ammunition Plant showed only 11 buildings of the 511 tested had radon levels greater than 4.0 pCi/l based on the 3-month and 12-month test periods. Eight of the 11 buildings with radon above 4.0 pCi/l are located on a limestone outcrop. Top soil in some of the yards is only eight-inches deep. Depending on meteorological and soil conditions (pressure, temperature, permeability, moisture, etc.) the gaseous radon diffuses into the atmosphere or buildings by ways previously stated. The location and method of building construction (concrete slab floor, cinder block walls, dirt crawl space ventilating into the occupied basement) contributed to the radon content in each structure.

Two production buildings used as control rooms had radon exceeding 4.0 pCi/l. These control rooms are essentially earth covered steel tanks with a doorway and exhaust stack. The radon content was reduced to less than 4.0 pCi/l by air dilution (running the exhaust fan continuously).

Installation of ductwork and an exhaust fan is currently underway in the 11th building having radon above 4.0 pCi/l. Testing will be done to determine if air dilution is a satisfactory method of mitigation in this building.

CONCLUSION

Mitigation of radon in buildings having a radon content of 4.0 pCi/l or higher can be accomplished by air dilution. However, air dilution is not completely satisfactory because of building heat loss and cost of electricity to run the fans. Long-term mitigation involves caulking, plastic sheet sealed over dirt crawl spaces, etc. Long-term mitigation techniques will be considered after building modifications have been completed.

REFERENCES

¹EPA Pamphlet, "A Citizen's Guide to Radon," dated August 1986.

²United States Army Environmental Hygiene Agency, Technical Guide No. 164.

Figure 1
Radon 222 Decay Series

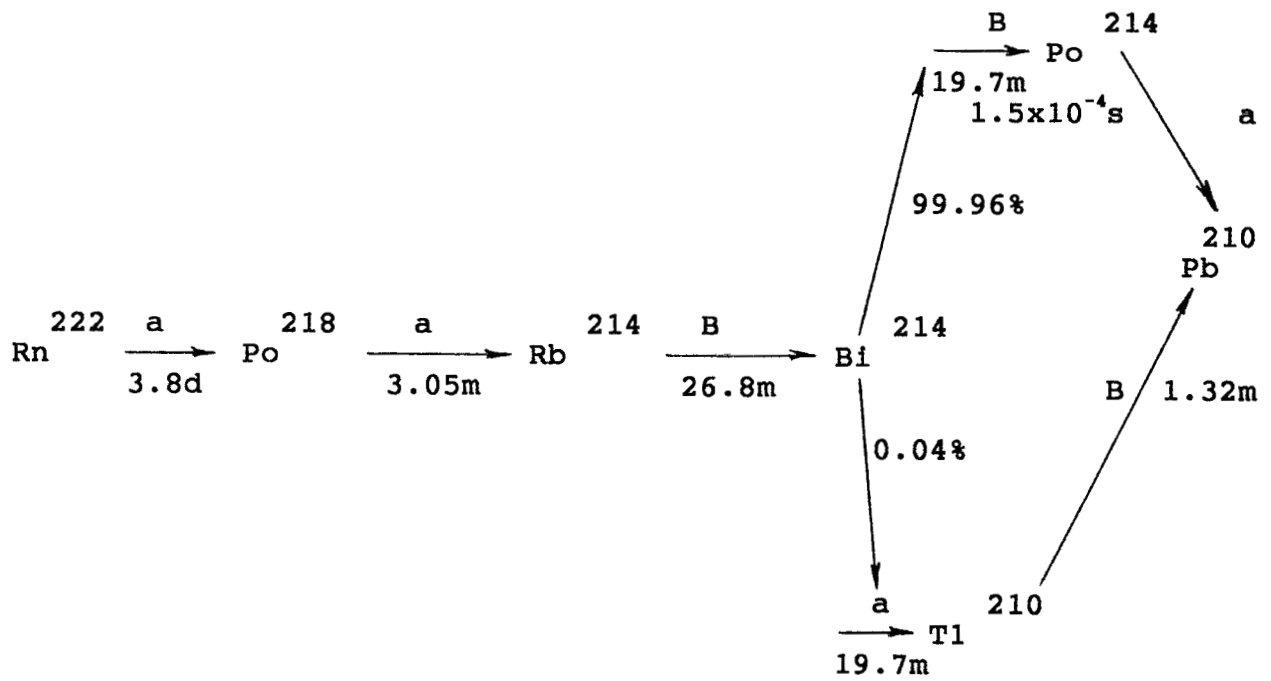
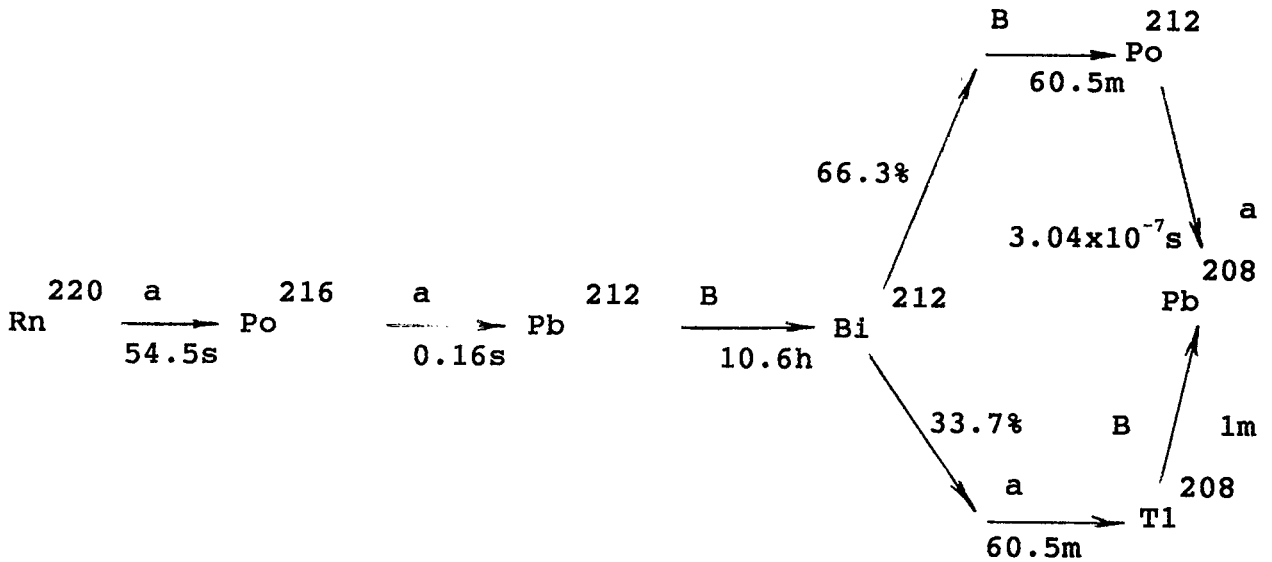


Figure 2
Thorium 220 Decay Series

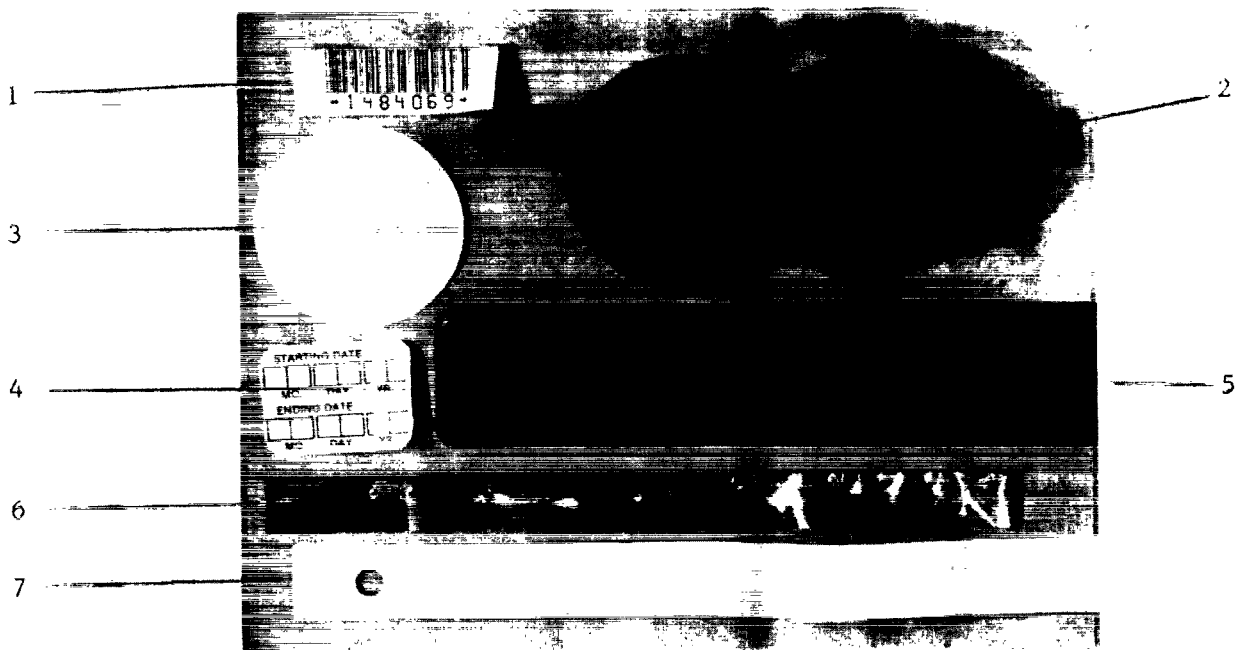


Legend for figures 1 and 2

s second
h hour
d day
a alpha particle

B beta particle
Rn radon
Po polonium
Rb rubidium

Bi bismuth
Tl thallium
Pb lead



- Legend
1. Bar code identification label
 2. Bottom and top of plastic cassette
 3. Filter
 4. Date label
 5. Radtrak label with identification number
 6. Detector strip
 7. Monitor hanging strip

Figure 3
Disassembled Alpha Track Monitor